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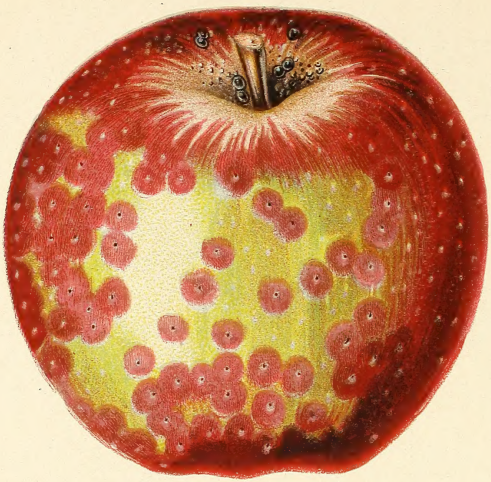

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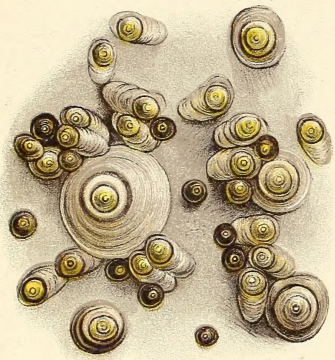

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APPLES INFESTED WITH SAN JOSE SCALE.

Fig. 1, Baldwin; fig. 2, Esopus (*Spitzenburg*); fig. 3, San Jose scales, enlarged.

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY—BULLETIN No. 84.
L. O. HOWARD, Entomologist and Chief of Bureau.

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FUMIGATION OF APPLES FOR THE SAN JOSE SCALE.

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BY

A. L. QUAINTANCE,
In Charge of Deciduous Fruit Insect Investigations.

ISSUED SEPTEMBER 30, 1909.

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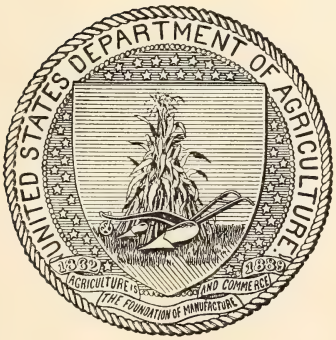

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., June 2, 1909.

Sir: I have the honor to transmit herewith for publication a manuscript entitled "Fumigation of Apples for the San Jose Scale," prepared by Mr. A. L. Quaintance, in charge of Deciduous Fruit Insect Investigations of this Bureau.

The possibility of the dissemination of the San Jose scale on fruit has been frequently under discussion, and while it is the consensus of opinion of American entomologists that this danger is negligible, many European governments have in operation laws and decrees providing for the inspection of imported American fruits and the exclusion of such as may show the presence of this insect.

The likelihood that the marking of the fruit by the scale will increase rather than diminish renders desirable some method of treatment which will destroy the insect and thus remove any objection to its importation or shipment. In cooperation with Mr. William A. Taylor, of Field Investigations in Pomology, Bureau of Plant Industry, an investigation was undertaken by the Bureau of Entomology to determine the possibility of fumigating apples with hydrocyanic acid and other gases. The results of this investigation are given in the accompanying manuscript, which I recommend for publication as Bulletin No. 84 of the Bureau of Entomology.

Respectfully,

L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FUMIGATION OF APPLES FOR THE SAN JOSE SCALE.

INTRODUCTION.

The possibility of the establishment in new localities of the San Jose scale (*Aspidiotus perniciosus* Comst.) from shipments of scale-infested fruit, principally apples and pears, has been the subject of frequent discussion among entomologists and others. On the whole it seems to be the consensus of opinion that, although this danger undoubtedly exists, the chances of establishment from this source are exceedingly remote.

The great bulk of the fruit harboring this insect is sold in cities and towns and the parings and refuse are mostly disposed of in a way to effectively prevent any young crawling "lice" from reaching plants upon which they could establish themselves. The fruit, furthermore, is offered for sale mostly during the late fall and winter, a time when the temperature is too low to favor the activity of the crawling young or to favor their production by the adult females. The danger of their establishment would perhaps be greatest in the case of varieties of fruit maturing in late summer or early fall, which would reach the markets some weeks before the approach of cool weather, thus affording a period for the breeding of the scales present and, should they succeed in reaching a suitable host plant, for the necessary growth of the young to enable them to survive the winter. Their chances of survival would be correspondingly increased if the infested fruit were shipped to a warm or subtropical climate. Also, infested fruit kept for a time during the winter in a warm room, or in a conservatory, closely adjacent to suitable potted or other host plants, might result in the infestation of these plants and the later spreading of the insects to plants out of doors.

In the case of fruit used for culinary and dessert purposes, the refuse parts, as peel and core, are very largely consigned to the garbage, effectively eliminating any danger from that source. With fruit eaten out of doors, as obtained from fruit stands, it is conceivable that the refuse parts might by a strange chance be discarded in a way to constitute a source of danger. Thus, a pedestrian passing along a street or country road, in the act of eating an apple, might carelessly throw aside the peel, which lodging in a suitable host plant might result in the scales obtaining a foothold. But it must be

remembered that the young crawling San Jose scale is comparatively fragile and quite susceptible to unfavorable conditions, and the chances would be greatly against it even were the described conditions present, very improbable in themselves.

Danger of infestation in this way would be limited practically to fruit on the market in late summer or early fall, as allowing a sufficient time before cold weather for the insect to become about one-third grown, since most individuals younger than this die during the winter, as well as those much older. Ordinary winter varieties of apples, as Ben Davis, York Imperial, Baldwin, Greening, etc., come on the market in cool climates so late in the season as to practically eliminate them as possible disseminators of scale under out-of-door conditions.

The history of the spread of the scale in the United States is of interest in this connection. The insect was present in California for years before its introduction into the East occurred. Much scale-infested fruit was unquestionably sent to various eastern markets, and thus unlimited opportunity was offered for its introduction in this way. Its actual establishment, however, so far as known, was brought about only by means of infested nursery stock received from a locality in California where the insect was abundant.

The foregoing remarks apply particularly to fruit consumed in the fall or early winter. If the fruit is held for any time in cold storage, the chances are still more increased against the insect's successful establishment. Holding the fruit for any considerable time in cold storage, in a temperature of from 30° to 32° F., results in the death of the younger individuals and older ones, especially those in a breeding condition. The survivors, as in the case of the insects under winter conditions out of doors, are mostly those about one-third grown, and the percentage of these which survive rapidly decreases with continued holding in cold storage. Hence, after the insects are again brought under favorable conditions, several weeks are required for them to reach a reproductive age, and the fruit exposed to warm temperatures for a necessary time for the development of the scales would most certainly become badly deteriorated, if not actually decayed, thus resulting in the premature death of the insects. In practice, fresh fruit is perhaps never held so long in a warm temperature before consumption. The probability of the young scales being able to continue development to maturity on fruit parings, etc., is scarcely to be considered, since this refuse would quickly decompose or dry.

The gradual dying of scales on fruit held in cold storage, during 1906–7 and 1907–8, is indicated in Tables II and XI, as determined at different times for comparison with the condition of scales on fumigated fruit. In the later examinations the live insects found were exclusively those about one-third grown.

On the whole, the danger of the scale becoming distributed by means of fruit is seen to be quite unimportant, and in the United States, where legislation against injurious insects finds its greatest development, this source of possible distribution, with a few exceptions, is ignored. The possibility, however, under certain exceptional conditions must be admitted, and this danger has appeared sufficient to warrant certain European governments in enacting legislation excluding from entry all fruits from America which show upon inspection the presence of the San Jose scale, including boxes, barrels, wrappings, etc., used for packing such fruit.

In the United States the scale each year is becoming more and more generally distributed, and the pest is now present in sections which were until recently quite free from it. In the Western and Eastern States it is especially prevalent, and while there are numerous orchards and fruit regions still uninfested, these will unquestionably be invaded. The States least infested are those immediately west of the Mississippi River, as Iowa, Kansas, Arkansas, etc., but in these the scale has also gained a foothold and its general spread in these States seems certain. In other words, the scale is now, or in a few years will be, present in the principal commercial orchards of the country, and the appearance on the market of fruit infested by the insect is an evil which will increase rather than diminish.

The intelligent use of lime-sulphur wash, or other effective scalecide, will unquestionably control the insect so far as preserving the life and vigor of the tree is concerned. But a little carelessness in spraying, the use of improper solutions, or unfavorable weather conditions at the time of making applications, may allow the survival of the scale in sufficient numbers to result, later in the season, in their settling in considerable numbers upon the fruit. The use of the lime-sulphur wash, perhaps, actually favors this condition.[a] It has but little penetrating and spreading power and may fail to kill some of the insects, especially on the younger growth where they are more or less protected by the pubesence or fine epidermal hairs. Young "lice" from insects which have thus escaped destruction, and from those elsewhere on the tree, upon hatching, are probably forced, in their search for a suitable place for settlement, upon the fruit, if this be present, on account of the coating of the wash upon the tree. The young crawling insects settle principally in the calyx basin and stem cavity of the fruit, although they are often in abundance promiscuously over the sides, as shown in Plates I and II. If infestation occur in early summer the fruit at picking time, in extreme cases, may be more or less incrusted with the insect; in well-sprayed orchards it should be present in but few or moderate numbers. The greatest pains should be taken by orchardists whose trees are infested

[a] See also remarks on this subject by C. L. Marlatt, in Bul. 46 of this Bureau, pp. 54–55.

with the scale to insure its destruction as completely as possible by spraying, not only to preserve the life of the trees, but to prevent the marking of the fruit.

In cases of light infestation the intrinsic value of the fruit is but little affected, although the reddish spots or circles disfigure it for market purposes, and its keeping qualities are perhaps reduced. Despite care in packing and grading in infested orchards, a certain amount of scaly fruit will usually find its way into the barrels or boxes, and thus be distributed. In this connection is presented a table (Table I), compiled from the reports[a] of Dr. C. Brick, chief inspector in the Station für Pflanzenschutz, at Hamburg, on the condition of American apples received at that port during the years from 1888–9 to 1906–7, inclusive, considered merely as to infestation by the San Jose scale, although report is made upon numerous other species of scale insects and certain fungous diseases found present.

TABLE I.—*Receipts at Hamburg of American apples from the winters of 1898–9 to 1906–7, inclusive, with number of packages infested with the San Jose scale.*

Season and origin of fruit.	Number and kinds of packages.			Total number of packages.	Number and kinds of packages infested by San Jose scale.			Total number infested packages.	Per cent infested.
	Barrels.	Boxes.	Miscellaneous packages.		Barrels.	Boxes.	Miscellaneous packages.		
Season 1898–1899:									
Canada and Nova Scotia.	14,484	133	.....	30,135	.....	.....	.....	602	1.99
Eastern United States...	11,875	.....	.....		3	.....	.....		
Western United States..	7	691	.....		7	577	.....		
Undetermined origin....	2,865.5	80	.....		16	5	.....		
Season 1899–1900:									
Canada and Nova Scotia.	24,647	665	.....	82,802	.....	.....	.....	2,586	3.12
Eastern United States...	52,004	805	25		974	.....	.....		
Western United States..	131	3,321	.....		11	1,581	.....		
Undetermined origin....	419	784	1		18	1	1		
Season 1900–1901:									
Canada and Nova Scotia.	4,439	80	.....	31,533	168	.....	.....	392	1.24
Eastern United States...	24,859	251	.....		74	.....	.....		
Western United States..	15	434	.....		.....	109	.....		
Undetermined origin....	1,422	24	9		20	21	.....		
Season 1901–1902:									
Canada and Nova Scotia.	4,903	1	.....	30,391	.....	.....	.....	4,095	13.40
Eastern United States...	19,786	.....	.....		1,772	.....	.....		
Western United States..	.....	3,255	.....		.....	1,757	.....		
Undetermined origin....	1,512	926	8		1	565	.....		
Season 1902–1903:									
Canada and Nova Scotia.	10,041	1,537	.....	158,453	167	.....	.....	11,265	7.10
Eastern United States...	13,135.7	82	.....		10,380	1	.....		
Western United States..	.....	768	.....		.....	426	.....		
Undetermined origin....	14,668	.....	.....		290	2	.....		
Season 1903–1904:									
Canada and Nova Scotia.	36,253	14,509	61	352,402	12	.....	.....	21,099	5.95
Eastern United States...	289,177	5,688	.....		18,796	1,457	.....		
Western United States..	.....	977	1		.....	743	.....		
Undetermined origin....	2,083	3,648	5		89	2	.....		
Season 1904–1905:									
Canada and Nova Scotia.	28,131	706	.....	209,618	1,470	.....	.....	6,244	2.98
Eastern United States...	154,017	1,135	.....		4,356	102	.....		
Western United States..	.....	57	.....		.....	10	.....		
Undetermined origin....	24,907	665	2		30	276	.....		
Season 1905–1906:									
Canada and Nova Scotia.	75,401	1,129	.....	239,212	1	.....	.....	26,570	11.10
Eastern United States...	139,011	537	.....		16,436	150	.....		
Western United States..	.....	9,904	.....		.....	8,254	.....		
Undetermined origin....	9,240	3,986	4		1,075	653	2		
Season 1906–1907:									
Canada and Nova Scotia.	404	1	.....	190,444	100	.....	.....	11,629	6.10
Eastern United States..	184,521	3,348	.....		10,250	6	.....		
Western United States..	.....	447	.....		.....	363	.....		
Undetermined origin....	2,161	6	3		872	38	.....		

[a] Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten, XVI–XXIV.

The work of Doctor Brick and his associates, as set forth in Table I, shows that an undesirable amount of scale-infested fruit finds its way into our export shipments, which, from the regulations in force, must be excluded from entry, entailing a considerable loss to exporters. On account of the general occurrence of the scale in American orchards, and the vicissitudes of spraying, the condition is not likely to improve, and the desirability of some expedient to obviate the objections, if possible, is apparent. The laws and edicts now in force in foreign countries relative to the importation from America of plants, fruits, and boxes and wrappings used for same, infested with injurious insects, principally the San Jose scale, together with those in effect in the United States, are given in abstract in the appendix to this article.

EXPERIMENTS IN FRUIT FUMIGATION.[a]

At the instance of Mr. Wm. A. Taylor, pomologist, of the Bureau of Plant Industry, of this Department, the Bureau of Entomology, cooperating with Mr. Taylor, began in the fall of 1906 a series of experiments to determine the possibility of treating scale-infested apples in a manner to destroy the insects without injury to the appearance and quality of the fruit. This work was followed entirely along the line of fumigation and aside from certain preliminary experiments hydrocyanic-acid gas was used, although limited tests were made with carbon bisulphid.

APPARATUS.

Much care was taken to construct a fumigating apparatus which would be as tight as possible and in the use of which the various operations of fumigation would be quite under control. Five equal-sized boxes were constructed out of tongue-and-grooved lumber, using two layers of boards with heavy building paper between, the whole fitting tightly together. The interior of each box was given two heavy coats of thick white lead paint and later treated with a shellac varnish. The inside dimensions of each box were 2.5 by 2.5 by 4 feet, and after deducting for certain pieces of timber used in the corners, and for platform for packages of fruit, contained 23.776 cubic feet. The apparatus was installed in a basement room, the boxes placed side by side, as shown in figure 1, *A–E*. The front of each box, forming the door, was entirely removable, as shown in the figure, and when in place fitted against a 3-inch heavy wooden rim all around, covered with thick felt

[a] The writer wishes especially to acknowledge the assistance of Mr. Jas. H. Beattie, in the construction of the fumigating boxes; and of Messrs. Fred Johnson, E. L. Jenne, and S. W. Foster, in the fumigation of fruit and in making examinations of the scale insects.

(fig. 1, box *C*), against which it was tightly pressed by the six clamps to each box (fig. 1, box *E*; fig. 2, *A*, *1a*).

To permit quick removal of gas at close of period of exposure, each box was supplied on lower rear side and at top with a 2-inch pipe opening and a tight valve, the lower series (fig. 1, *8a*) connecting with the common outlet pipe (*8*), extending to the outside of the building and opening above the level of the roof, the upper series (*5a*) joined to a pipe (*5*), connected with the electric blower (*6*), for generating the air blast. This arrangement permitted the simultaneous clearing out of the gas in all of the boxes, or one or more boxes could be operated independently of the others. About fifteen minutes were required to clear the boxes of gas, though this was of course greatly diluted with fresh air almost immediately after the blower was put in operation.

To insure a uniform distribution of gas in the boxes from the start, a small generating box was constructed and placed on the floor at about the center, as shown in detail in figure 2, *A*, *B*, *3 a–d*. This box, except as noted, was fairly tight, with a door in front for introducing the chemicals and four square hollow arms with the ends open and seven ½-inch holes along each side. A shaft of heavy steel wire extended from side to side in the upper part of the box, projecting on one side in the form of a crank. A small metal cup was rigidly attached to the middle of the wire shaft to receive the potassium cyanid (fig. 2, *A*, *3b*). Beneath the cyanid cup was space for the introduction of a small jar containing the necessary sulphuric acid and water (*3c*). A string was attached to the crank end of the shaft bearing the cyanid cup, by means of which the cup could be inverted and the cyanid thus dropped into the jar beneath. With the door of the generating box closed, the gas was mostly forced out through the four arms, insuring a fairly uniform distribution from the moment the chemicals were brought together.

A heavy slat platform (fig. 2, *A*, *2*) was provided somewhat above the generating box, and on this were placed all packages of fruit to be treated, as barrels, baskets, boxes, etc. The apparatus as described proved well suited for the work in hand, and it is believed was as tight as it was practicable to make it. At no time during fumigation could the odor of escaping gas be detected at cracks or around the door, though the gas was forced out into the room to some extent when the air blast was turned on.

In the operation of fumigation the two valves of a box were first closed, the package of fruit to be fumigated placed on the slat platform, the weighed cyanid lightly wrapped in tissue paper, put into the cyanid cup, and just before closing the fumigating box the jar of measured acid and water was inserted into the generating box

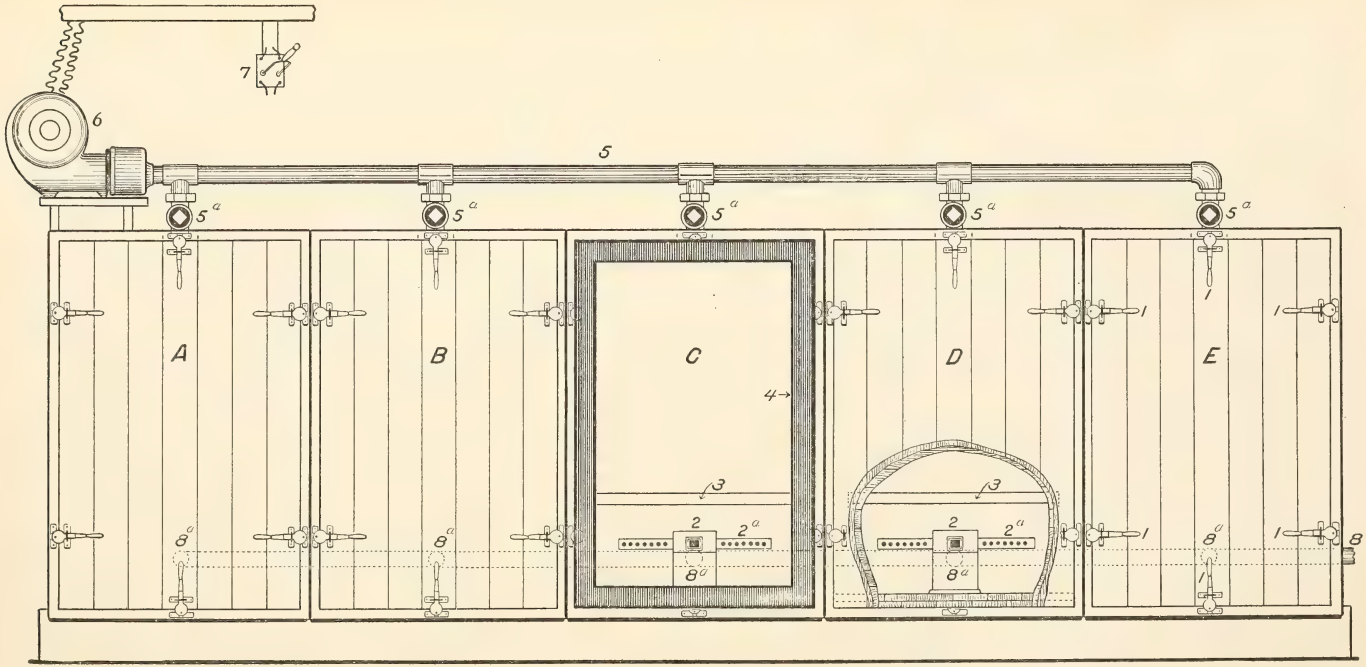

FIG. 1.—Fumigation Apparatus: *A* to *E*, the respective boxes; 1, clasps for clamping in door; 2, discharge box; 2*a*, perforated arms for distributing gas; 3, slat platform for support of fruit packages; 4, flange and felt cushion against which door is clamped; 5, air supply pipe from blower; 5*a*, air inlet valves to respective boxes; 6, blower and motor; 7, switch board; 8, gas outlet-pipe; 8*a*, location of outlet valves on respective boxes, connecting with outlet pipe, 8. (Original.)

beneath the cyanid. The door was then put in place and fastened with the clamps. At the proper time the cyanid was dropped into the acid jar by pulling the string extending to the outside, and fumigation continued for the desired time. At the close of the period of fumigation, the lower valve was first opened, then the upper valve, and the electric blower started, thus driving out the gas.

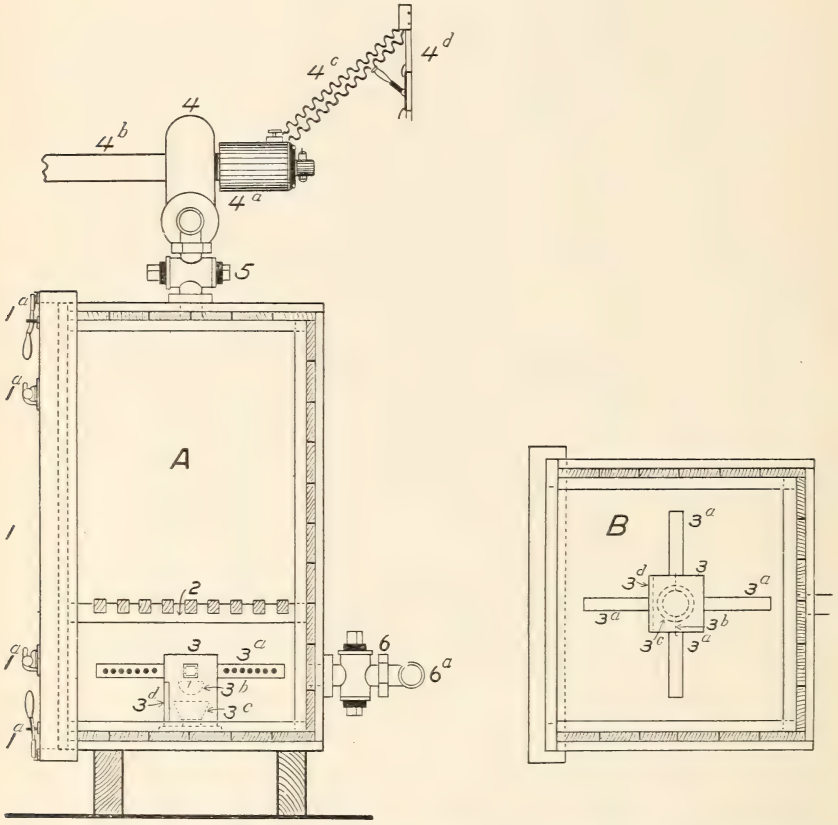

FIG. 2.—Fumigation Apparatus. A: 1, Door in place; 1*a*, door clasps; 2, slat support for fruit packages; 3, discharge box; 3*a*, perforated arms; 3*b*, cyanid cup on wire pulley; 3*c*, sulphuric acid and water jar; 3*d*, door of discharge box; 4, air blast fan or blower; 4*a*, motor; 4*b*, air suction pipe to outside of building; 4*c*–*d*, switch board and connections; 5, valve for inlet of air to box; 6, valve for discharge of gas from box; 6*a*, outlet pipe. B: Showing construction of discharge box; same lettering as in A. (Original.)

Chemically pure potassium cyanid and sulphuric acid were used in all the tests and also distilled water. The cyanid was weighed on chemical balances and the liquids measured by means of a burette graduated to 0.1 c. c. The chemicals were uniformly used in the proportion of potassium cyanid, 1; sulphuric acid, 2; and water, 4.

EXAMINATIONS OF THE SCALE INSECTS.

After fumigation, the fruit was kept in an outbuilding on the Agricultural Department grounds, the temperature varying mostly between 30° and 40° F., being rarely higher than 45° F. In 1906–7 the fumigated fruit for examination as to condition of scales was taken direct from this storehouse; but in 1907–8 it was first held for a couple of days in a warm room, which induced a prompt discoloration of the dead scales, greatly facilitating their recognition. The plan was to make two examinations of the scales on each lot of fruit fumigated: The first two weeks, and the second four weeks, after the time of fumigation, and this in the main was adhered to. All examinations of scales were made by aid of a dissecting microscope, and a dissecting needle was used to remove the scale proper, exposing the body of the insect. The color of the body was relied upon to determine if the insect were dead or alive, and there was not often difficulty in thus definitely classifying them. In some cases, examination of doubtful specimens was made under a compound microscope to detect possible body movements, and a method of staining was used to a limited extent. In all cases, specimens doubtfully dead were regarded as alive, and, as will be noted in the tabulated results for 1906–7, these doubtful cases were numerous.

In 1907–8, however, the expedient of warming the fruit for a couple of days before each examination always resulted in the prompt discoloration of the scales, leaving no doubt as to their condition. In view of the uniformly successful results in killing the scales in all experiments made in 1907–8, and many of them duplicates of those made in 1906–7, it is considered practically certain that the insects regarded as alive in 1906–7 were in reality dead, but not showing sufficient discoloration for positive recognition on account of the comparatively low temperature at which they were held.

The supply of infested fruit for fumigation was kept in the original barrels in a local cold-storage plant, being taken out shortly before needed, the time depending upon the nature of the test to be made. Thus in treatment of fruit in a dry condition it was necessary to remove it several days in advance, so that the moisture condensing on the cold fruit would dry. In the fumigation of fruit in a moist condition, however, the condensed moisture on the cold fruit immediately after coming from cold storage put this in the desired condition for experiment.

An important question in the employment of hydrocyanic-acid gas in the destruction of scale insects on apples was the possibility of injury to the fruit. In this matter the Bureau of Entomology had the expert aid of Mr. William A. Taylor, pomologist, of the Bureau of Plant Industry, and his associates, who are also responsible for the correctness of names of varieties. There is also the question of

possible poisoning of the fruit by absorption of the gas. It is believed that there is very little, if any, gas taken up by the fruit during the process of fumigation—certainly not enough to result in harm to the consumer. The writer, his associates, and many others have freely eaten of fumigated fruit at various times, and in several instances the fruit after wiping was eaten within thirty minutes after it had been taken out of the fumigating box.

To insure uniformity in conducting the tests and in recording results, a blank form 5 inches by 8 inches in size was used throughout, as follows:

FRUIT FUMIGATION EXPERIMENTS. Box No..... Exp. No.....
Locality..... Date..... Fruit.....
Variety..... Maturity..... Source.....
Size of fumigatorium..... Package, size.....
Amount deducted..... Fumigant, rate.....
Amounts of chemicals used.....
Exposure..... Begun..... Closed.....
Temperature..... Condition of fruit as to moisture.....
Degree of scale infestation.....
.....
Condition of scale before treatment.....
.....
Results of treatment.....
.....
.....
.....
..... Notes by.....

EXPERIMENTS IN 1906–7.

The fumigation tests with hydrocyanic-acid gas during 1906–7 may be grouped as follows:

(1) Strength-of-gas series.
(2) Length-of-exposure series.
(3) Package series.
(4) Variety-of-fruit series.
(5) Injury-to-fruit series.
(6) Low-temperature series.

Except in the sixth series all tests were made in the basement room referred to, which was supplied with steam pipes for purposes of heating the building, maintaining a temperature for the basement of from 65° to 70° F. An abundant quantity of each variety of fruit used was kept untreated to determine the condition of the scales from time to time during the winter. The condition of the scales on Baldwin and Rhode Island Greening apples during the winter of 1906–7 is shown in Table II, and in addition to furnishing a basis of comparison with the treated fruit will serve to show the increasing mortality of the scales as the season progressed.

TABLE II.—*Condition of San Jose scale on unfumigated apples during the winter of 1906–7. For comparison with condition of scale on fumigated fruit.*

Date of examination.	Variety of apple.	Number of apples examined.	Number of scales alive.	Number of scales dead.	Per cent of scales alive.	Remarks.
November 12, 1906	Baldwin	10	559	441	55.90	Fruit kept in out-of-door storehouse.
November 26, 1906	do	10	572	428	57.20	Do.
December 13, 1906	do	10	533	477	53.30	Do.
February 20, 1907	do	10	360	640	36.00	Do.
February 28, 1907	do	10	102	898	10.20	Do.
December 3, 1906	Rhode Island Greening.	10	302	698	30.20	Held in cold storage 4 weeks. After Dec. 3 in out-of-door storage house.
December 14, 1906	do	10	277	723	27.70	Do.
December 29, 1906	do	10	256	744	25.60	Do.
January 14, 1907	do	10	235	765	23.50	Do.
February 27, 1907	do	10	999	999	.10	Do.

STRENGTH-OF-GAS SERIES.

From the first-mentioned or strength series of tests it was desired to obtain information on the strength of gas necessary to kill the scale, and incidentally the possible effect of these various strengths upon the fruit. The apples used were of the Baldwin variety, from western New York (Niagara County), and badly infested with the scale. The fumigation was done November 12, 1906, with fruit but a few days in cold storage from the orchard and perfectly dry when treated. Ordinary open market baskets were used, of about one-third bushel capacity, and were nearly filled with the infested fruit. Fumigation continued for forty-five minutes. The essential details are given in Table III.

TABLE III.—*Effect of different strengths of hydrocyanic-acid gas on scales and fruit. Exposure, forty-five minutes. (Strength series.)*

Experiment No.—	Variety of apple.	Kind of package.	Rate at which potassium cyanid was used.	Number of scales examined.	Effect on scales.	Effect on fruit.
			Gr. per cu. ft.			
1	Baldwin	⅓ bu. basket.	0.05	3,162	Many alive	No injury.
2	do	do	0.10	1,426	All dead	Do.
3	do	do	0.15	1,678	do	Do.
4	do	do	0.20	1,963	do	Do.
5	do	do	0.25	3,615	do	Do.
6	do	do	0.30	3,920	do	Do.
7	do	do	0.35	2,006	do	Do.
8	do	do	0.40	2,131	do	Do.
9	do	do	0.45	1,862	do	Do.
10	do	do	0.50	2,059	do	Do.

From the table it will be noted that all scales were killed without injury to the fruit, at all strengths except where 0.05 gram potassium cyanid per cubic foot was used. In this experiment (No. 1) at first

examination, two weeks after treatment, a total of 13 scales of the 942 examined was regarded as alive. At the second examination, a month after treatment, all scales were plainly dead, being discolored and drying up.

LENGTH-OF-EXPOSURE SERIES.

In the second or exposure series it was desired to determine the effect on the fruit of various periods of exposure and also the effect of the treatments upon the scales. The variety employed was Baldwin, from the same orchard in western New York, and badly infested with the insects. The fruit was dry when treated and was placed in one-third bushel baskets. The fruit was fumigated November 13, 1906, with results as shown in Table IV.

TABLE IV.—*Effect of different periods of exposure on scales and fruit. Strength, 0.20 gram potassium cyanid per cubic foot. (Exposure series.)*

Experiment No.—	Variety of apple.	Kind of package.	Rate at which potassium cyanid was used.	Length of exposure.	Number of scales counted.	Effect on scales.	Effect on fruit.
			Gr. per cu. ft.				
11	Baldwin	⅓ bu. basket	0.20	3 hours	3,360	All dead	No injury.
12	do	do	0.20	2½ hours	1,968	do	Do.
13	do	do	0.20	2 hours	3,047	do	Do.
14	do	do	0.20	1½ hours	1,510	do	Do.
15	do	do	0.20	1¼ hours	2,007	do	Do.
16	do	do	0.20	1 hour	2,100	do	Do.
17	do	do	0.20	50 minutes	1,518	do	Do.
18	do	do	0.20	40 minutes	1,172	do	Do.
19	do	do	0.20	30 minutes	2,185	do	Do.
20	do	do	0.20	20 minutes	1,361	do	Do.

It will be noted that all exposures were effective in killing the insects, as determined by the two subsequent examinations, without any injury to the fruit.

PACKAGE SERIES.

In the third or package series it was desired to determine the possibility of successfully treating the scales on apples in the original packages, but opened up in various practicable ways. Some of the fruit treated was but a short while from cold storage, and the condensed moisture on the surface presented afforded opportunity to observe if this lessened the effect of the gas on the insect or contributed to injury to the fruit. Several varieties of apples were used, as Ben Davis, York Imperial, Baldwin, and Rhode Island Greening. The work of fumigation extended over the period from November 14, 1906, to January 22, 1907, as stated more in detail in the remarks following the table. Table V presents the essential features of the tests, grouped according to varieties of fruit and character of experiment.

TABLE V.—*Effect of fumigation with hydrocyanic-acid gas on scales and fruit in different kinds of packages.* (*Package series.*)

Experiment No.—	Variety of apple.	Kind of package and condition of fruit.	Rate at which potassium cyanid was used.	Length of exposure.	Number of scales examined.	Effect on scales.	Effect on fruit.
			Gr. per cu. ft.	*Hours.*			
26	Ben Davis	Barrel, slat bottom, top out; fruit dry.	0.20	¾	2,030	A few alive	No injury.
27	do	Barrel, slat bottom, top in; fruit dry.	.20	¾	2,070	All dead	Do.
28	do	Barrel just from cold storage, iron header in lower end; fruit wet from condensation.	.30	1	2,467	1 scale alive	Do.
29	do	Barrel not opened; 1 hour from cold storage.	.30	1	1,709	Many live scales.	Do.
30	do	Barrel with twenty ¾-inch auger holes in each end; fruit moist.	.30	1	1,805	All dead	Do.
31	do	Barrel with twenty ¾-inch auger holes in each end; fruit dry.	.30	1	1,820	do	Do.
32	do	Barrel open at top; fruit dry.	.30	1	1,505	do	Do.
33	York Imperial	Barrel unopened; fruit dry.	.30	1	1,570	Many live scales.	Do.
34	do	Barrel, top open; fruit dry.	.30	1	4,640	do	Do.
35	Baldwin	Barrel, iron header in bottom; fruit moist.	.30	1	3,150	All dead	Do.
36	do	Barrel, top open; fruit moist.	.30	1	3,450	do	Do.
37	do	Barrel, iron header in bottom, top open; fruit moist.	.30	1	3,150	do	Do.
38	do	Barrel, lower head with twenty ¾-inch auger holes; fruit moist.	.30	1	3,300	do	Do.
39	do	Barrel, both ends with twenty ¾-inch auger holes; fruit moist.	.30	1	3,401	do	Do.
40	Rhode Island Greening.	Barrel, iron header at bottom; fruit dry.	.30	1	5,535	A few scales alive.	Fruit badly injured.
41	do	Bushel box, fruit unwrapped; dry.	.30	1	2,970	All dead	Do.
42	do	Bushel box, fruit wrapped; dry.	.30	1	3,825	do	Do.

In experiments Nos. 26 and 27 the fruit was fumigated November 14, 1906, and as the variety used, Ben Davis, was not sufficiently infested with scales for purposes of later examinations, about one-third bushel of badly infested Baldwins was placed in the center of each of the barrels and carefully repacked. The slat bottom used consisted of several strips of wood fastened so as to replace the lower head and hold the fruit in place. In No. 26 the upper barrel head was also removed, leaving the fruit fully exposed above and below, and, as the packages in all cases were supported by the open platform in the box, the gas could pass through the barrel, thoroughly surrounding the fruit. The treatment of barrel in No. 27 differed only in leaving in the top of the barrel, this being open at the bottom only. Two examinations of the Baldwin apples from center of barrels were made at intervals of two weeks. In the first, Novem-

ber 26, 1906, a few scales on one apple in No. 26 were regarded as doubtfully dead, and hence were classed as alive; and upon the second examination, December 14, six insects on one fruit and one on another were also doubtful.

In experiment No. 28 an iron screen "header" was used in the lower end of the barrel, the top not being removed. This header, devised by Mr. S. J. Dennis of Field Investigations in Pomology, as shown in figure 3, consisted of a circular framework of strong iron strips, somewhat smaller than the barrel head, to which was attached a semicircular piece hinged along the middle, fitting over one-half of the frame beneath, and firmly held by a locking device on the rim.

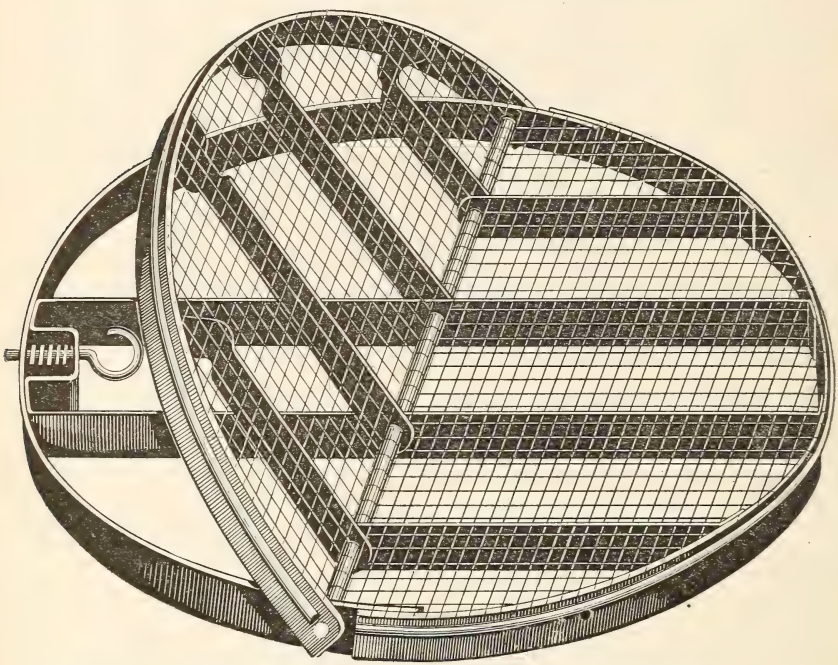

FIG. 3.—Special barrel "header" for replacing lower barrel head in fumigating directly over discharge box. (Original.)

The header, with screened surface turned inward, when pressed in place fitted the head tightly and firmly held the apples in their original positions, and permitted free access of the gas. This barrel when fumigated had been one and one-half hours from cold storage and the fruit was thoroughly wet from condensation of moisture, the temperature of fruit being 1.5° C. On account of scarcity of scale insects, only one examination was made, December 26, 1906, the fruit examined being taken from the top, middle, and bottom of the barrel. Of the 1,662 scales examined, one from an apple in the center of the barrel was regarded as doubtfully dead. No injury to the fruit was subsequently noted, despite the presence of the moisture.

In experiment No. 39 the barrel was fumigated just as it came from the cold-storage plant an hour previous. Owing to the moist conditions under which it had been stored, the cracks of the barrel were very tight, and it was hardly expected that the gas could penetrate the package sufficiently to kill the scales to any extent, which proved to be the case. The package was fumigated December 12, 1906, and December 27 apples from the top, middle, and bottom of the barrel were examined. Of the 1,709 scales counted, many were unquestionably alive.

With Nos. 30 and 31, twenty $\frac{3}{4}$-inch auger holes were bored into each end of the barrel, thoroughly perforating them to allow ready access of the gas. The barrel used in No. 30 was an hour from cold storage, and the fruit was wet with condensed moisture, the temperature of the fruit being 1° C. In case of No. 31, the fruit was thoroughly dried by spreading on the floor of the basement room, and then repacked. Fumigation was done December 12 and 13, respectively, and examinations made December 27 and 28, using apples from the top, middle, and bottom of the barrels, and in neither were any live scales to be found, nor was any injury to the fruit to be noted, then or subsequently.

Experiments Nos. 33 and 34, using the York Imperial variety, were made December 13. With No. 33 the fruit was well dried on the floor of the basement room, and then repacked, the barrel headed up as usual. In this package (examined December 28), of a total of 1,570 scales counted, 152 were unquestionably alive. In No. 34 the fruit had been taken from cold storage about eighteen hours before, and kept in the basement room. The top of the barrel was removed; otherwise the package was undisturbed. The first examination (December 28) of fruit from the top, middle, and bottom of the barrel included a total of 4,640 scales, of which 91 were considered doubtfully dead. Upon the second examination (January 15), including 2,680 scales, 6 were doubtfully dead.

In experiments Nos. 35 to 39, using the Baldwin variety, the fruit had been held in ordinary cellar storage by the orchardist in western New York until about January 1, when it was shipped to Washington, and received January 17, and at once placed in cold storage until January 22, when it was removed for fumigation. As shown in the table, these included a variety of tests, all scales being killed and without injury to the fruit. But one examination of this lot was made (February 20–21), using apples as previously from the top, middle, and bottom of barrels.

In Nos. 40 to 42 the Rhode Island Greening variety was used, also from the same orchard in western New York. Fumigation of No. 40 was done December 12, and owing to the scarcity of infested apples of this variety, about one-third bushel was placed in the bottom, center, and top of the barrel, respectively, using Baldwin and Ben Davis apples to fill up the balance of the barrel. The fruit was care-

fully packed and the "iron header" put in place, the open end down. The single examination, made December 29, of fruit from the three parts of the barrel included 2,290 scales, of which 10 were doubtfully dead. In Nos. 41 and 42, fumigated December 1, the usual commercial apple box was used, in the former the fruit being unwrapped, and in the latter wrapped with the paper usually employed for this purpose. In both cases the fruit was examined twice (December 19 and 31) and all scales were found dead. With this variety, however, namely, Rhode Island Greening, from western New York, there was marked injury to the fruit from the gas. This injury was evidenced by a browning or "scalding" of the skin, especially around the calyx end of the fruit, including the calyx basin and adjacent parts. Plate II, figure 2, shows the color and locality of typical gas injury to this variety, which very closely resembles the ordinary cold-storage "scald."

VARIETY-OF-FRUIT SERIES.

To test the susceptibility of various varieties of apples to gas injury a miscellaneous collection was secured from the market in Washington. The origin of the fruit was not known, and it was free from the San Jose scale. About one peck of apples of each sort was used, placed in one-third bushel baskets, and to each basket were added 20 badly infested Baldwin apples, to determine the effect of treatment on scales. Three of the baskets were placed in each fumigating box, and the entire 15 thus exposed simultaneously. The varieties used and other details are given in Table VI.

TABLE VI.—*Effect of hydrocyanic-acid gas on different varieties of apples. Exposure, one hour; potassium cyanid used, 0.30 gram per cubic foot. (Variety series.)*

Experiment No.—	Variety of apple.	Kind of package.	Rate at which potassium cyanid was used.	Length of exposure.	Number of scales examined.	Effect on scales.	Effect on fruit.
			Gr. per cu. ft.	*Hours.*			
43	Tolman sweet	⅓-bu. basket[a]	0.30	1	1,037	All dead.	No injury.
	Yellow Bellflower	do.[a]	0.30	1	1,057	do.	Do.
	Fallawater	do.[a]	0.30	1	1,109	do.	Do.
	Winesap	do.[a]	0.30	1	1,010	do.	Do.
	Fameuse	do.[a]	0.30	1	950	do.	Do.
	York Imperial	do.[a]	0.30	1	891	do.	Do.
	Ben Davis	do.[a]	0.30	1	986	do.	Do.
	Lavaar	do.[a]	0.30	1	750	do.	Do.
	Pound Sweet	do.[a]	0.30	1	1,210	do.	Do.
	Rhode Island Greening	do.[a]	0.30	1	940	do.	Do.
	Northern Spy	do.[a]	0.30	1	1,195	do.	Do.
	King	do.[a]	0.30	1	967	do.	Do.
	Grimes Golden	do.[a]	0.30	1	910	do.	Do.
	Baldwin	do.[a]	0.30	1	1,140	do.	Do.
	Peck Pleasant	do.[a]	0.30	1	750	do.	Do.

[a] In each basket were also placed 20 scale-infested Baldwins to determine effect on scales. Apples from Center Market, Washington, D. C.

Fumigation was done November 30, 1906, and the fruit was kept under observation for several weeks. No gas injury whatever developed and, as will be noted, all the scales on the infested Baldwins were killed. The absence of injury to the Rhode Island Green-

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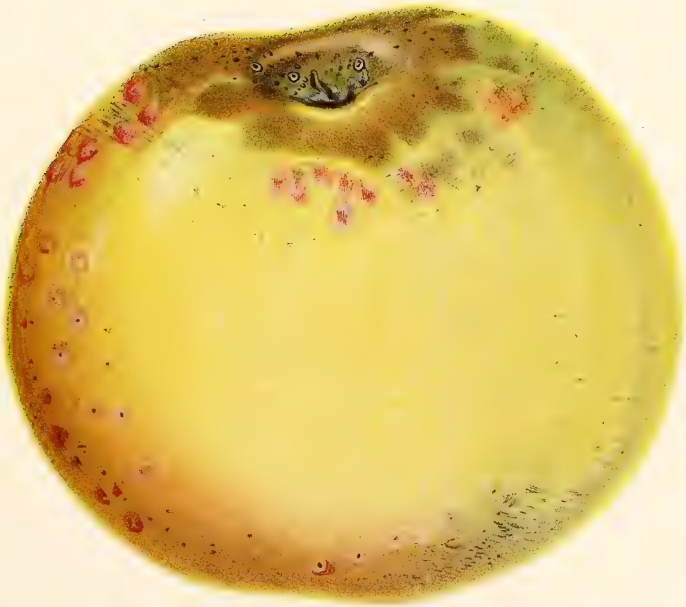

2

APPLES INFESTED WITH SAN JOSE SCALE.

Fig. 1, Rhode Island Greening; fig. 2, same variety, showing also discoloration from effect of fumigation with hydrocyanic-acid gas.

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ing variety, used in this instance, is noteworthy, in view of the invariable injury noted with this sort from western New York.

The following day, December 1, additional fruit of all of the varieties above listed in the table was fumigated, using gas, however, at the strength of 0.50 gram of potassium cyanid per cubic foot—an excessive amount. A final examination of this fruit, January 5, showed that no injury had resulted in the use of gas at this strength, including the Rhode Island Greening.

RHODE-ISLAND-GREENING-INJURY SERIES.

The injury resulting from fumigation to the Rhode Island Greening variety from western New York required further tests to determine, if possible, a strength of gas or period of exposure which, while effective against the scale, would not cause injury to the fruit. The experiments bearing on this subject are brought together in Table VII.

Nos. 44, 44a, and 44b, while made to determine the relative effectiveness of the gas on scales on dry, moist, and wet fruits, are here inserted as bearing on the subject in hand. All the fruit was from the same orchard and kept under the same conditions. It arrived in Washington from the orchardist on October 18, and was at once placed in cold storage until fumigated.

Nos. 44, 44a, and 44b were fumigated December 1, 1906, and Nos. 53 to 59, January 22, 1907. Subsequent to fumigation fruit was kept in the storage house on the Agricultural Department grounds, as described. The further details are given in the table below.

TABLE VII.—*Effect on the Rhode Island Greening apple of different strengths of hydrocyanic-acid gas, with different periods of exposure. Fruit loose in one-third bushel baskets.*

Experiment No.—	Condition of fruit.	Rate at which potassium cyanid was used.	Length of exposure.	Date of examination.	Effect on fruit.			Total number of apples.
					Number badly injured.	Number slightly injured.	Number showing no injury.	
		Gr. per cu. ft.	*Hours.*					
44	Dry	0.30	1	Jan. 3	9	17	24	50
44a	Moist	0.30	1	do	3	14	19	36
44b	Wet	0.30	1	do	3	14	17	34
52	Slightly moist	0.15	1	Jan. 28	1	23	28	.....
				Feb. 4	1	25	26	52
53	do	0.15	2	Jan. 28	16	18	15	.....
				Feb. 4	19	23	7	49
54	do	0.15	4	Jan. 28	22	19	11	.....
				Feb. 4	28	20	4	52
55	do	0.20	1	Jan. 28	4	19	25	.....
				Feb. 4	4	25	19	48
56	do	0.20	2	Jan. 28	19	19	7	.....
				Feb. 4	19	21	5	45
57	do	0.20	4	Jan. 28	31	12	5	.....
				Feb. 4	40	8	0	48
58	do	0.25	1	Jan. 28	16	15	15	.....
				Feb. 4	25	16	5	46
59	do	0.30	½	Jan. 28	2	15	39	.....
				Feb. 4	2	16	38	56
Check		Not treated	.....	Jan. 28	0	0	0	43
				Feb. 4	Many fruits showing scald.			.....

As shown above, all lots of fruit of this variety from the western New York orchard were injured by fumigation. The injury increased in extent along with the increase in period of exposure. A stronger dose for a shorter period of exposure was less injurious than a weaker one for a longer period, as seen by comparison of Nos. 54 and 59. It will also be noted from Nos. 44, 44a, and 44b that injury does not depend upon whether the fruit be dry, wet, or moist at time of treatment. The injury, in fact, was less pronounced on the moist and wet samples than on the dry fruit. The increased injury noted at time of second examination of Nos. 52 to 59 was undoubtedly due in part to the appearance of the so-called "cold-storage scald," to which this variety is quite susceptible, as shown by the untreated fruit kept for comparison. With Nos. 44, 44a, and 44b, the examinations were made too long after treatment to avoid danger of confusion of cold-storage scald, though it may be said that gas injury was noted soon after treatment.

As bearing on the possible influence of moderate or excessive moisture on fruit at time of fumigation, the following tests are brought together, in part from other tables, and some are not elsewhere presented:

TABLE VIII.—*Effect of fumigation with hydrocyanic-acid gas on fruit in a dry, moist, and wet condition.*

Experiment No.—	Variety of apple.	Kind of package and condition of fruit.	Rate at which potassium cyanid was used.	Length of exposure.	Effect on scales.	Effect on fruit.
			Gr. per cu. ft.	*Hours.*		
40	York Imperial	½ bu. basket; fruit dry	1. 5	1	No record	No injury.
40a	do	½ bu. basket; fruit wet	1. 5	1	do	Do.
44	Rhode Island Greening.	½ bu. basket; fruit dry	0. 30	1	All dead	Badly injured.
44a	do	½ bu. basket; fruit moist	0. 30	1	do	Do.
44b	do	½ bu. basket; fruit wet	0. 30	1	do	Do.
28	Baldwin	Barrel; fruit wet	0. 30	1	One doubtful	No injury.
30	do	Barrel; fruit moist	0. 30	1	All dead	Do.
35	do	do	0. 30	1	do	Do.
36	do	do	0. 30	1	do	Do.
37	do	do	0. 30	1	do	Do.
38	do	do	0. 30	1	do	Do.

COLD-STORAGE SERIES.

In order to test the fumigation process upon a larger scale, approximating what might obtain in commercial practice, a larger fumigatorium was constructed, 6 by 6 by 8 feet. The sides, ends, and top were made separately, using 2-inch square lumber for the framework. These frames were covered with 10-ounce duck, which was treated with two coats of boiled linseed oil. Previous to bolting the frames together, strips of heavy felt cloth were glued where the frames came in contact, giving a very tight union. On the floor, a

wide piece of heavy linoleum was used, and the framework screwed down firmly all around, also using felt strips to insure tightness. This made a very tight box which proved quite satisfactory for the work. The necessary potassium cyanid was divided into four parts, one of which was used near each corner of the fumigatorium.

To provide for removal of gas at end of period of exposure a large canvas box, 12 by 12 inches square, extended from a slide door opening at the rear of the fumigatorium to an adjacent window. A large electric fan was placed inside the fumigatorium and operated from the outside, forcing the air toward the outlet. With this arrangement it required about twenty minutes to sufficiently clear the box of gas to permit of opening it. The whole outfit was placed in one of the cold-storage rooms of a local cold-storage plant, in which the temperature was uniformly 30° F. This furnished opportunity to determine the effectiveness of the gas at a comparatively low temperature and under conditions which might become necessary in the actual fumigation of fruit in cold-storage houses.

Packages Nos. 60 to 67 were fumigated January 29 and examined for condition of scales on February 21. Nos. 68 to 70 were fumigated February 25 and examined March 15. These latter were made to repeat some of the earlier tests, to secure corroborative data. The fruit used was of the Baldwin variety and had been held in the same cold-storage room since October, and undisturbed in the original barrels, except that used in boxes which was packed from one of the barrels of this lot. In Table IX the features of the work are presented more in detail:

TABLE IX.—*Effect of fumigation with hydrocyanic-acid gas on scales and fruit at cold-storage temperature, 30° F.*

Experiment No.—	Variety of apple.	Kind of package (fruit dry).	Rate at which potassium cyanid was used.	Length of exposure.	Number of scales examined.	Effect on scales.	Effect on fruit.
			Gr. per cu. ft.	*Hours.*			
60	Baldwin	Barrel, each end with twenty ⅝-inch auger holes.	0.30	1	3,600	All dead	No injury.
62	do	Barrel, top open	0.30	1	3,250	do	Do.
63	do	Barrel, iron header in bottom.	0.30	1	3,800	do	Do.
64	do	Box, fruit unwrapped	0.30	1	3,600	do	Do.
65	do	do	0.30	1	2,330	do	Do.
66	Rhode Island Greening.	⅓ bu. basket	0.30	1	2,400	do	No record.
67	Baldwin	do	0.30	1	2,230	do	No injury.
68	do	Barrel, top open	0.30	1	2,350	A few scales doubtful.	Do.
69	do	Barrel, iron header in bottom.	0.30	1	2,950	1 scale doubtful.	Do.
70	do	Barrel, each end with 15 1-inch auger holes.	0.30	1	3,400	All dead	Do.

In examining the fruit, apples were selected from the top, middle, and bottom of the barrel, as usual. It will be noted that all scales were killed, except in case of Nos. 68 and 69. After fumigation of Nos. 68 to 70 it was found that one of the quarter packages of cyanid in which the total dose had been divided had failed to drop into the acid jar beneath, so that the quantity of cyanid used was in reality at rate of 0.225 gram per cubic foot, instead of 0.30 gram as indicated in the table. In No. 68, four scales were found on fruit from the center of the barrel which were considered doubtful. In No. 69, one scale only was doubtful, and this also on an apple found in the middle of the barrel.

In summarizing the hydrocyanic-acid gas tests during the winter of 1906–7 it must be said that the results were far from satisfactory. In all cases of fumigation where the apples were more or less loose, as in baskets, the scales were invariably all killed, and in the tests of the effect of the gas upon the various varieties of apples no injury whatever resulted, even though excessive strengths were used—much stronger than necessary to destroy the scales. The exception of the Rhode Island Greening from western New York, however, is to be noted, and as shown in Table VII no strength of gas was found which did not injure the fruit.

In the package series, including the treatment of fruit in boxes and barrels as would be necessary in commercial use, there was lack of uniformity in killing the scales. As already stated, this was probably more apparent than real and resulted from error in classification of the insect as to whether dead or alive, as the fruit was held under temperature conditions which would perhaps greatly favor their preservation and natural color. However, in all cases where the barrel heads were perforated with auger holes and in boxes with fruit wrapped or unwrapped all scales were killed.

TESTS OF CARBON BISULPHID.

In the preliminary tests of fumigants, one of those tried was carbon bisulphid. The first test was made November 14, placing scale-infested Baldwin apples in one-third bushel baskets on the platform in the fumigating boxes. The carbon bisulphid was exposed in shallow dishes placed on top of the fruit. The period of exposure was uniformly three hours, the doses, however, varying as shown in the table. On account of the poor results secured in this test, carbon bisulphid was again tried December 14 (Nos. 45 to 47, inclusive), the fruit being placed on the floor of the boxes and the carbon bisulphid dishes above, so that if possible the fruit would be more thoroughly subjected to the fumes, as the liquid evaporated and the gas sank to the floor. In this latter, infested

Rhode Island Greening apples were used, as shown in the following table:

TABLE X.—*Effect of fumigation with carbon bisulphid on scales and fruit.*

Experiment No.—	Variety of apple.	Kind of package.	Fumigant and rate at which used.	Time of exposure.	Number of scales examined.	Effect on scales.	Effect on fruit.
			C. c. per cu. ft.	*Hours.*			
21	Baldwin	½-bushel basket	CS_2 0.069	3	1,618	Live scales abundant.	No injury.
22	do	do	do	3	1,405	do	Do.
23	do	do	CS_2 0.1384	3	2,165	do	Do.
24	do	do	CS_2 0.2768	3	2,040	do	Do.
25	do	do	CS_2 0.453	3	995	do	Do.
45	Rhode Island Greening.	Apples loose on floor of box.	CS_2 1.81	3	770	do	Do.
46	do	do	CS_2 0.453	3	650	do	Do.
47	do	do	CS_2 0.138	3	930	do	Do.

Examination of fruit as to condition of the scales in Nos. 21 to 25 was made November 27, about two weeks after treatment; and Nos. 45 to 47, December 29, approximately an equal interval after treatment; each lot was again examined about two weeks later. In No. 25 the carbon bisulphid was used at the rate of 0.453 c. c. per cubic foot. This is equivalent to 1 pound to 1,000 cubic feet. Using this as a normal, doses were consecutively decreased by one-half, Nos. 21 and 22 being duplicates. In the second series of tests, in which the fruit was placed on the floor on the boxes, the carbon bisulphid was used much stronger in the case of No. 45—that is, 1.81 c. c. per cubic foot, approximately equal to 4 pounds per 1,000 cubic feet. As to the period of exposure, namely, three hours, it was realized that this was perhaps too short, but in actual practice it would be undesirable to greatly lengthen this on account of the need of expedition in work of this character. It is not improbable that where fruit could be subjected for several hours, as overnight, to carbon-bisulphid fumes a heavy dose might be effective in destroying the scales and without injury to the fruit.

As shown, none of the strengths with the three-hour exposure was at all effective in killing the scale. In the case of No. 45, where the greatest strength was used, there were 120 live scales, of a total of 770 examined, or a little more than 15 per cent of the insects counted; or on the basis of live scales present, as shown by the condition of the checks, approximately 28 per cent came through alive. In no instance was there any injury to the fruit.

EXPERIMENTS IN 1907–8.

In the package series of tests made during the winter of 1906–7, with the exception of the commercial boxes and barrels with both heads perforated with auger holes, a few scales were found on fumigated fruit which were so nearly normal in color and appearance

as to give rise to doubt as to their condition, and these were therefore uniformly regarded as alive. The preceding season's work indicated that great range in strengths of gas was possible without injury to the fruit, excepting in the case of one variety, and in the case of loose fruit at least was entirely reliable in killing the scales. The variability in results of treatment of fruit in barrels required further tests, as if put to practical test it would be highly desirable that fumigation could be done without disturbing the fruit as originally packed. The tests in 1907–8 were therefore directed toward establishing a treatment for fruit in original packages, varying the strength of gas and the period of exposure. As in the preceding season, 0.30 gram of chemically pure potassium cyanid was adopted as a normal, and, while perhaps stronger than actually required, it was desirable to have an excess of strength, especially since considerable latitude was allowable without danger of injury to the fruit. This dosage is furthermore approximately that already employed in treatment of dormant, deciduous-fruit nursery stock—that is, 1 ounce to each 100 cubic feet of space in the fumigatorium. The Baldwin variety was used, obtained, as previously, from Niagara County, N. Y., but from another orchard than the fruit used in 1906–7. The fruit was fumigated from November 29 to December 2, and at once placed in the outbuilding on the Agricultural Department grounds previously mentioned, in which the temperature ranged mostly from 30° to 40° F.

Extended examinations of scales on apples before fumigation showed that 81.1 per cent of these were alive, ranging in age from quite young to mature gravid females, occurring mostly in the stem and calyx cavities. The condition of the scales on fruit at this time and at different dates subsequently is shown in Table XI, serving for comparison as to condition of scales in fumigated fruit.

TABLE XI.—*Condition of San Jose scale on unfumigated Baldwin apples during the winter of 1907–8 for comparison with condition of scale on fumigated fruit.*

Date examined.	Number of scales alive.	Number of scales dead.	Total number scales examined.	Per cent alive.
November 29, 1907	524	122	646	81.10
December 16, 1907	796	217	1,013	78.50
December 27, 1907	344	109	453	78.00
January 3, 1908	930	499	1,429	65.08
February 3, 1908	302	454	756	39.94
March 3, 1908	101	954	1,055	9.57

PACKAGE SERIES, 1907–8.

The fruit had been held in cold storage for a few weeks and at the time of fumigation the apples from the middle of the barrels were somewhat moist, not having yet dried from the condensation of

moisture. In Nos. 83 to 86 fruit from barrels was packed in the usual way, wrapped and unwrapped, in commercial apple boxes.

The first examination for scale on the treated fruit was begun on December 14 and concluded December 24, and reexamination was done from January 3 to 8, using fruit from the top, middle, and bottom of barrels each time.

In all tests in 1907–8 the plan was adopted of holding the fruit in a warm room, where the temperature was from 70° to 75° F., for two days previous to examination to bring about a more marked discoloration of the dead scales and eliminate as much as possible any doubt as to their exact condition. The method of treatment was found to blacken the dead scales without exception, and there was never any question as to whether the insect was dead or alive. The essential features of the test are given in the subjoined table:

TABLE XII.—*Effect of fumigation with hydrocyanic-acid gas on scales and fruit in different kinds of packages.* (*Package series, 1907–8.*)

Experiment No.—	Variety of apple.	Kind of package.	Rate at which potassium cyanid was used.	Length of exposure.	Number of scales examined.	Effect on scales.	Effect on fruit.
			Gr. per cu. ft.				
71	Baldwin	Barrel, iron header in bottom.	0.30	1 hour	4,228	All dead.	No injury.
72	do	do	.30	3 hours	3,602	do	Do.
73	do	do	.30	All night	4,899	do	Do.
74	do	do	.50	3 hours	4,207	do	Do.
75	do	Barrel, top open	.30	1 hour	4,898	do	Do.
76	do	do	.30	3 hours	2,879	do	Do.
77	do	do	.30	All night	4,562	do	Do.
78	do	do	.50	3 hours	3,677	do	Do.
79	do	Barrel with 20 ¾-inch auger holes in each end.	.30	1 hour	4,603	do	Do.
80	do	do	.30	3 hours	4,391	do	Do.
81	do	do	.30	All night	3,657	do	Do.
82	do	do	.50	3 hours	4,257	do	Do.
83	do	Box, fruit unwrapped	.30	do	2,690	do	Do.
84	do	do	.30	All night	2,355	do	Do.
85	do	Box, fruit wrapped	.30	3 hours	3,263	do	Do.
86	do	do	.30	All night	2,985	do	Do.

It will be noted from the table that in every case the treatment was entirely effective in killing the scale insects and that no injury resulted to the fruit.

To corroborate these results, several of the tests were repeated, using fruit from the same source, but held longer in cold storage, namely, until February 5. The Baldwin and Roxbury Russet varieties were used and after fumigation were kept in the outhouse mentioned. The percentage of live scales in untreated Baldwins at time of fumigation was 24.4 and on the Roxbury Russet 70. In these tests it will also be noted (Table XIII) that all scales were killed and without injury to the varieties of fruits used.

TABLE XIII.—*Corroborative results of effect of fumigation with hydrocyanic-acid gas on scales and fruit in different kinds of packages.* (*Package series 1907–8.*)

Experiment No.—	Variety of apple.	Kind of package.	Rate at which potassium cyanid was used.	Length of exposure.	Number of scales examined.	Effect on scales.	Effect on fruit.
			Gr. per cu ft.	*Hours.*			
88	Baldwin	Barrel, top open	0.30	1	3,400	All dead.	No injury.
89	do	do	.30	3	3,231	do	Do.
90	do	Barrel, with 20 ¾-inch auger holes in each end.	.30	1	2,748	do	Do.
91	do	do	.30	3	3,290	do	Do.
92	Roxbury Russet.	Box, fruit wrapped	.30	1	2,768	do	Do.
93	do	do	.30	3	2,567	do	Do.

One barrel of scale-infested Rhode Island Greening apples, from Niagara County, N. Y., but from another orchard than the first used in 1906–7, was fumigated February 5 to determine if injury would result as in the earlier tests. An iron header replaced the usual barrel head, the open end turned down over the generator. Three examinations of this fruit were made, the counts including 2,860 scales, all of which were found to be dead. The fruit, however, was more or less injured and scalded as described for 1906–7.

SUMMARY OF RESULTS.

Strength-of-gas series (*Table III*).—In the fumigation of fruit loose in baskets all scales were killed with strengths of potassium cyanid at rate of from 0.10 to 0.50 gram per cubic foot, and exposed forty-five minutes. Five hundredths of a gram of cyanid per cubic foot was not entirely effective. No injury resulted to the fruit treated, namely, the Baldwin.

Length-of-exposure series (*Table IV*).—Baldwin apples loose in baskets were not injured by the use of potassium cyanid at the rate of 0.20 gram per cubic foot with periods of exposure ranging from twenty minutes to three hours. In every instance the scale insects were all killed.

Package series, 1906–7 (*Table V*).—Fumigation of fruit in barrels opened in various ways to permit access of gas gave apparently variable results as to effect on the scales. All insects were not with certainty killed, except in the case of fruit in boxes, wrapped and unwrapped, and in barrels in which each head had been perforated with numerous auger holes. Scales on apples in unopened barrels were not killed to any extent, as the packages were too tight to allow entrance of the gas.

Package series, 1907–8 (*Table XII*).—In the package series of tests in 1907–8, with boxes, fruit wrapped and unwrapped, and with barrels opened in various ways, using potassium cyanid at the rate of 0.30

gram per cubic foot and with exposures of one hour, three hours, and overnight, all scales were uniformly killed. The holding of fruit in a warm room for a couple of days previous to examination resulted in a marked discoloration of the dead insects, leaving no doubt as to their condition.

Variety-of-fruit series (*Table VI*).—Numerous varieties of apples, including the principal commercial sorts, fumigated for one hour and using potassium cyanid at the rate of 0.30 and 0.50 gram per cubic foot, were not in any way injured.

Rhode-Island-Greening-injury series (*Table VII*).—The only variety of apple used in the tests showing gas injury was the Rhode Island Greening from western New York. Other fruit of this variety of unknown source was not injured by an excessive strength of the gas. No strength of gas or period of exposures was determined which was not injurious to western New York Greenings. Injury was more pronounced on fruit subjected to a long exposure than when a heavier dose and shorter exposure were given.

Fumigation of dry, moist, and wet fruit (*Table VIII*).—Observations made at different times on fruit fumigated in a dry, moist, and wet condition showed that its condition in this respect was immaterial. Apples thoroughly wet by applying water with a spray pump were not in the least injured, and all scales were killed.

Cold-storage series (*Table IX*).—Fumigation of scale-infested apples in a local cold-storage plant with the temperature 30° F. showed that adequate diffusion of the gas occurred, killing all of the scale insects, and without injury to the fruit.

Mortality of scales on fruit during winter (*Tables II and XI*).—Data obtained at different times on condition of scales on untreated fruit for comparison with their condition on fumigated fruit showed, as occurs normally out of doors, that the very young and old scales die, the survivors being mostly those about one-third grown. In the case of fruit held in storage in 1907–8, until March 3, only about 9.5 per cent of scales present were alive, and these were exclusively about one-third grown. In 1906–7 the percentage of live scales present on Baldwin apples, on the 12th of November, 55.90, dropped by December 3 to 30.20, and on the Rhode Island Greening variety, from 30.20 per cent alive on same date to one-tenth of 1 per cent alive by February 27—practical extermination.

Carbon-bisulphid series (*Table X*).—Treatment of scale-infested fruits with carbon bisulphid at strengths varying from 0.069 to 1.81 cubic centimeters per cubic foot and for a period of three hours failed to kill the scales to any extent. No injury resulted to the varieties of fruit used, namely, Baldwin and Rhode Island Greening.

CONCLUSIONS AND RECOMMENDATIONS.

The data presented point out, it is believed, the practicability of destroying the San Jose scale on apples and suggests the desirability of the adoption of the practice of fumigation by exporters if such treatment will result in the acceptance by foreign countries of fruit so treated. A certificate of proper fumigation on each barrel, box, or package should constitute a sufficient guaranty that any scales present had been killed. It is considered probable that, if desirable, fumigation could be practiced in the case of numerous fruits, as pears, oranges, lemons, etc. In fact, the writer understands that it has been the practice of the California state board of horticulture to fumigate such fruit when desirable during the past several years.

In the fumigation of apples in barrels it would appear sufficient to remove the upper head only, or to use for the original heading boards with numerous $\frac{3}{4}$ or 1 inch auger holes—a total of 15 or 20 at each end. Fruit packed in usual commercial boxes, wrapped or unwrapped, would need no special preparation, as the openings between the several slats would allow sufficient gas to enter.

APPENDIX.

SYNOPSIS OF LAWS AND DECREES IN FORCE IN FOREIGN COUNTRIES BEARING ON THE INTRODUCTION OF LIVE PLANTS AND FRESH FRUITS.

ARGENTINA.

Plants and plant products, from countries where there exists any infection which might affect the agricultural interests, are classed as doubtful, and as such are submitted to treatment and disinfection, as the authorities may prescribe. Fruits and vegetables for consumption are held under the same ruling. These restrictions are applied to produce from countries infested with the San José scale and the Phylloxera. (Regulation of 1902, Law No. 4082.)

AUSTRIA-HUNGARY.

Prohibits (decree of April 20, 1898) importation from America of living plants, grafts, and layers, and fresh plant refuse of every kind, as well as the barrels, boxes, and other coverings in which such goods or refuse may be packed, and fresh fruit and the refuse of fresh fruit, as well as the packings which may cover the same, when examination on frontier shall prove presence of San Jose scale. Admission limited to Bodenbach-Tetschen, Trieste, and Fiume. Also prohibits transit of such goods through the Empire. The Secretary of Agriculture is empowered to make exceptions. (Regulations still in force March 9, 1909.)

BELGIUM.

Importation and transit of fresh fruits, living plants, and fresh parts of plants sent from the United States can take place only by ports of Antwerp, Ghent, and Ostende, upon production of a certificate from competent authority attesting that products are not contaminated by San Jose scale. If not accompanied by certificate, products can not be delivered until inspected, and, if not exempt, must be destroyed with packings; cost of all service at expense of importer. Order in effect March 15, 1899. Does not apply to shipments in direct transit by railway under supervision of customs authorities. (Decrees still in force February 8, 1909.)

BOLIVIA.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.[a]

BRITISH COLUMBIA.

The importation and transit of fresh fruits, nursery stock, etc., found to be infested with injurious insects is prohibited. Fruit infested with the San Jose scale is not allowed to be sold or offered for sale in the Province. Any fruit found to be infested with the San Jose scale or other dangerous scale insects or the codling moth is either condemned and destroyed or shipped to a point without the Province. Systematic inspection of imported fruit is carried on at the port of entry. Nursery stock found to be infested is disinfected or destroyed.

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[a] By "special restrictions" is meant those which relate to restriction of plants or fruits infested with injurious insects. No reference is intended to customs duties which may be in force.

CANADA.

Prohibits (San Jose scale act, March 18, 1898) importations of nursery stock from the United States, Australia, Japan, and Hawaii. Stock so imported to be destroyed. Importer liable to penalty prescribed in section 6, customs tariff ($200 for each offense). There are exempted (1) greenhouse plants, including roses grown under glass; (2) herbaceous perennials; (3) herbaceous bedding plants; (4) all conifers; (5) bulbs and tubers.

Amended (Council order January 5, 1901) to permit entry of nursery stock, if fumigated, at the following customs ports, between the dates given; Winnipeg, Manitoba, and St. John, New Brunswick, from March 15 to May 15 in spring, and in autumn from October 7 to December 7; St. Johns, Quebec, Niagara Falls, Ontario, and Windsor, Ontario, from March 15 to May 15 in spring, and in autumn from September 26 to December 7; Vancouver, British Columbia, from October 1 to May 1 of the following year. All shipments made at risk of consignees. Dakota cottonwood admitted at Brandon and Winnipeg, Manitoba, without fumigation.

While the act provides for the restriction of importation of fruits infested with the San Jose scale, this provision is not enforced, as danger from this source is considered negligible.

CHILE.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

CHINA.

Living plants, fresh fruits, etc., may under ordinary conditions be imported without special restrictions. Strict regulations covering these articles with the establishment of quarantine may be issued from time to time at various ports. These regulations apply to localities infested with cholera, and exceptions are provided for under certificate from medical officers. The following is an extract from the Shanghai quarantine regulations of 1906.

Shanghai Quarantine Regulation, 1906.

A. FROM PORTS DECLARED INFECTED.

Fresh fruit.—If accompanied by a certificate or bill of health from the medical officer of the port showing that no cholera is present in the district, apples, bananas, citrons, grapes, lemons, liches, loquats, mangosteens, mangoes, olives, oranges, peaches, pears, pineapples, pomegranates, pumeloes, and sugar cane, if in sound condition and cleanly packed as cargo. (Apricots, cherries, figs, melons, plums, raspberries, strawberries, tomatoes, and thin-skinned fruit are prohibited.)

Vegetables.—Tubers, roots, bulbs, and bamboo shoots, if cleanly packed as cargo. (Celery, lettuce, endive, and other leaf vegetables are prohibited.)

Plants of any kind to which earth or vegetable mold adheres. Importation not permitted.

B. FROM PORTS FROM WHICH THE DECLARATION OF INFECTION HAS BEEN REMOVED.

Earth and mold.—If adherent to plants or bulbs in small quantities and cleanly packed, importation permitted when accompanied by certificate from the medical officer of the port that the earth and mold are from a plague-free district.

COLOMBIA.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

CUBA.

There are no special restrictions affecting the importation of fresh fruits. A law promulgated on the 16th of July, 1906, subjects all citrus plants from other countries to a strict fumigation. In the absence of facilities for this fumigation, the governor decreed, on October 30, 1906, as a temporary measure until said service could be established, that plants from Florida be admitted if they come accompanied by a certificate of an official entomologist guaranteeing that they are free from injurious insects. (Regulation still in force, December 28, 1908.)

DENMARK.

Importation of potatoes or parts thereof from North America is prohibited. (Decree of January 28, 1876.)

There are no other special restrictions affecting the importation of living plants, fresh fruits, etc.

FRANCE.

Prohibits (decree of November 30, 1898) entry into and passing through France of trees, shrubs, products of nurseries, all nursery cuttings, and all other plants or parts of living plants, as well as fresh débris from them, from the United States, as well as cases, sacks, etc., used for packing.

Also, prohibits fresh fruit and débris when examination proves presence of insects at entry into France.

This decree, according to the minister of agriculture, is still in force. (March 8, 1909.)

GERMANY.

Prohibits (decree of February 5, 1898) the importation of living plants and parts of living plants from America, and barrels, boxes, etc., used for packing; also fresh fruits or fresh parts of fruits, when examination at port of entry shows presence of San Jose scale. The imperial chancellor is authorized to grant exceptions.

Amended (act of July 10, 1900) by annulling the regulation providing that dried and evaporated fruits from the United States be inspected. Such fruits are now admitted without other charge than customs duty.

By decree of August 16, 1900, the restrictions of the decree of February 5, 1898, are made applicable to Japan; and also, by decree of June 3, 1907, to Australia. List of places at the boundary where plants may be introduced will be found in Circular No. 41 of the Bureau of Entomology.

GREECE.

Seeds of all description and bulbs only from Holland are allowed to be imported into Greece. The importation of fresh fruits, except from the island of Crete, is prohibited.

GUATEMALA.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

HAITI.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

ITALY.

Laws are in force relative to importation of grapevines, grape cuttings, etc., likely to harbor Phylloxera. Other classes of nursery stock and fresh fruit are apparently subject only to customs duty.

MEXICO.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

THE NETHERLANDS.

Prohibits (San Jose scale law of May 23, 1899) the importation and transit from America, direct or indirect, of all kinds of living trees and shrubs, or living parts thereof, including boxes, kegs, barrels, or other objects which serve or may have served for packing.

NICARAGUA.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

NORWAY.

To protect against American gooseberry mildew (*Sphærotheca mors-uvæ*), it is forbidden to import gooseberry plants or parts thereof, including the fresh fruit.

There are no other special restrictions as affecting importation of live plants, fresh fruits, etc.

PANAMA.

There are no special restrictions affecting the importation of live plants and fresh fruits, etc.

PARAGUAY.

There are no special regulations in force affecting the importation of living plants, fresh fruits, etc.

PERSIA.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

RUSSIA.

No restriction is placed on the importation of fruit or vegetables, the prohibition for southwestern Russia (south of Radzivil customs-house to the Black Sea) having been removed (Collection of Laws 1901, No. 82, sec. 1767). The importation of living plants and parts thereof (excepting vines to which special rules apply) is allowed from many countries of Europe and the Orient, but is apparently not permitted from America. (Collection of Laws, Vol. VI, edition 1904; do. No. 27, act 322.)

SAN SALVADOR.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

SANTO DOMINGO.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

SIAM.

There are no special restrictions affecting the importation of living plants, fresh fruits, etc.

SPAIN.

The Spanish regulations (International Customs Journal No. 24, Spain, 1906–7, p. 18, etc.) prohibit importation from any country not adhering to the Antiphylloxera Convention of trees, shrubs, or live plants, except under a certificate of the Spanish consul at point of origin that the Phylloxera does not exist there, and that the said trees have come straight through without unpacking. American vines may be imported into Spanish provinces officially declared phylloxerated. Live plants and fruits from the United States may not be imported if found by the inspector to be infested with the San Jose scale. The importation of potatoes or any parts thereof from any part of America is prohibited.

SWEDEN.

To protect against American gooseberry mildew (*Sphærotheca mors-uvæ*) it is forforbidden to import gooseberry plants or fresh fruits of same. Otherwise there are no special restrictions affecting the importation of living plants, fresh fruits, etc. (Royal ordinances, September 22, 1905; September 14, 1906.)

SWITZERLAND.

Prohibits plants; fresh fruits may be imported only through customs bureau at Basle, where they are subject to examination by an expert for the San Jose scale or other parasites. There are no restrictions to direct importation of dried fruits. This inspection provision has been also recently applied to Australian fruits (February 15, 1909).

TURKEY.

A note from the minister of foreign affairs to the United States minister at Constantinople, dated October 18, 1899, states that the Imperial Government has decided to interdict the importation of trees, plants, and fruits coming from the United States. No further information has been received.

UNITED KINGDOM.

Live plants, fruits, cuttings, etc., may be imported without special restriction except as below mentioned. Gooseberry bushes may not be brought into Great Britain except from the Channel Islands. Currant bushes are similarly restricted except under license from board of agriculture and fisheries. Gooseberry and currant bushes may not be landed in Ireland from any place out of Ireland without license from department of agriculture and technical instructions issued only to cover importations for experiments in propagating new varieties.

LAWS AND REGULATIONS OF THE VARIOUS STATES OF THE UNITED STATES BEARING ON THE INTRODUCTION, TRANSPORTATION AND SALE OF FRESH FRUITS INFESTED WITH THE SAN JOSE SCALE OR OTHER INJURIOUS INSECTS. [a]

A recent inquiry (May 29, 1909) as to the provisions of the various State crop pest laws relative to the introduction, sale, or shipment of fruit infested with the San Jose scale shows much lack of uniformity in this regard. While most of the States now have in effect laws restricting the distribution of nursery stock infested with injurious insects or diseases, these do not apply to fruit, except in a few States. In several of the States, however, the laws give authority for action as to infested fruit, but this provision is not always enforced.

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[a] The full text of these laws will be found in Bulletin 61 of this Bureau.

The following States have no restrictions affecting the introduction or shipment of scale-infested fruits: Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

Strict regulations are in force in regard to infested fruits as well as nursery stock in the following States:

CALIFORNIA.

Under the horticultural laws of California, the state board of horticulture is empowered to fumigate and hold all shipments of fruit infested with the San Jose scale until the insects are dead. The fruit, however, can not be destroyed, as this pest already exists in the State.

Shipments going into counties of California are subject to the ordinances of the county, and may be destroyed according to county regulations. Shipments from one county to another in the State are treated in the same manner.

COLORADO.

The law empowers the destruction of any fruit or nursery stock coming into the State which has upon it the living San Jose scale. The consignor has the privilege of reshipping the infested fruit or nursery stock out of the State.

IDAHO.

Idaho specifically prohibits the importation and shipment of fruit infested with the San Jose scale. Fruit bearing the marks of infestation is not permitted to be sold in the State except for purposes of manufacturing by-products.

IOWA.

While there is no warrant to exclude introduction into the State of fruit infested with the San Jose scale, it is not permitted to ship fruit from orchards in the State known to be infested with the insect.

MONTANA.

The Montana horticultural laws provide that all deciduous and other fruit infested with the San Jose scale, from any State, shall be destroyed by burning or otherwise, which also applies to fruit from within the State.

OKLAHOMA.

The Oklahoma law provides that fruit or other articles of commerce, as nursery stock, found infested with the San Jose scale shall be placed under quarantine and by practical methods the insect destroyed or eradicated. The regulations as to importation from other States, however, relate only to nursery stock.

OREGON.

The Oregon law declares that the offering for sale of fruit infested with the San Jose scale constitutes a public nuisance. Upon the finding of infested fruit, by the county inspector, the party having same for sale is promptly notified to destroy the insects by drenching with kerosene oil or to destroy the fruit. In case of failure, this work is attended to by the county inspector, or in case of large shipments in Portland the fruit is destroyed at the crematory.

Infested fruit shipped into the State and discovered before it is offered for sale may be returned to the consignor if he so requests. There is also in operation a law making it a misdemeanor to offer for sale, to pack for sale, or to deliver to a transportation company for shipment, infested fruit, but this law is held in abeyance except in extreme cases.

UTAH.

The Utah law prohibits the possession or sale of fruit infested with the San Jose or other scale insects, and the larvæ of the codling moth. Shipments of scale-infested fruit are destroyed by burning, or are saturated with kerosene.

WASHINGTON.

The Washington law requires the treatment of all infested nursery stock, regardless of origin. The shipper or consignee is allowed to treat for the San Jose scale by dipping in strong solution of lime-sulphur wash or by fumigation with hydrocyanic-acid gas, under the direction of an official inspector. Fruits are allowed to be treated in the same manner. Apples and pears infested with the codling moth are destroyed and are not permitted to be offered for sale in the markets.

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